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Inaugural Dissertation

ON

ABSORPTION.

From: Wilson, Goodridge
An inaugural dissertation on
absorption ... Philadelphia,
E. Oswald, 1797.

New York Academy of Medicine
June 16, 1958

AN

John Wilson

INAUGURAL

DISSERTATION

ON

ABSORPTION.

BY GOODRIDGE WILSON,
OF VIRGINIA.

“ Terra salutiferas herbas, eademque nocentes,
“ Nutrit; et urticæ proximæ sæpe rosa est.”

OVID.

1826
Philadelphia:

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M,DCC,XCVII.

ANNUAL

DISSERTATION

ABSORPTION.

MEDICAL PROGRESS

BY COOBRIDGE WILSON.

THE UNIVERSITY OF CHICAGO

1870

Printed by E. OSWALD, No. 179 South Second Street.

M, DCC, XCIII.

AN
INAUGURAL DISSERTATION,
SUBMITTED TO THE
EXAMINATION
OF THE
Rev. JOHN EWING, S. T. P. *Provost*;
THE
T R U S T E E S
AND
M E D I C A L P R O F E S S O R S
OF
The University of Pennsylvania,
FOR THE
D E G R E E
OF
DOCTOR OF MEDICINE,
ON THE TWELFTH DAY OF MAY, 1797.

C

TO
My Brother and Preceptor

SAMUEL WILSON, M. D.

OF

CARTER'S-VILLE, VIRGINIA;

AND

To my Preceptor,

CASPAR WISTAR, M. D.

Adjunct Professor of Anatomy, Surgery and Midwifery,

IN THE

UNIVERSITY OF PENNSYLVANIA.

GENTLEMEN,

ALLOW me to acknowledge, that all a Man can owe to his Friend, a Pupil to his Preceptor, or one Brother to another, I owe to you.

Whether I have profited by your Instruction as Physicians, and your Example as Men, Time and my future Conduct must shew.

That you may long enjoy that Blessing, which you are so skillful and industrious in restoring to others, is the earnest Wish of your much obliged and very affectionate Brother and Pupil,

GOODRIDGE WILSON.

ON ABSORPTION.

ABSORPTION, in the living animal body, is a power which certain vessels have of drawing particles of matter into their invisible orifices, and conveying them into the general mass of circulating fluids.

THAT the human body inhaled, was the doctrine of HIPPOCRATES ; and has been the opinion of most of his successors, down to the present time.

THOUGH this doctrine has been so long in vogue, and is of such ancient date, yet it was not till very lately known by what particular vessels Absorption is performed.

SOME of the Ancients attributed this office to the Arteries ; but the discovery of the circulation of the Blood, shewing the course of arterial fluids, to be from the centre to the surface, i. e. directly opposite to the motion of those fluids, which are supposed to pass from without inwards, was of itself sufficient to set this opinion aside.

And an opinion now generally received is, that the extreme terminations of Arteries, are the true Exhalents, or organs by which that fluid is effused, which serves to moisten and lubricate all the surfaces of the animal body.

ANOTHER opinion of the Ancients was, that the Veins absorbed ; and this appeared to gather strength from the improvements in Anatomy after the circulation was discovered. Now as this discovery shewed, that the Veins return those fluids to the Heart, which the Arteries carry from it, it was a very natural conclusion, that they had opposite offices in other respects ; and as the extreme arteries are the exhalents, so the veins were supposed to be the absorbents. This opinion, so plausible in itself, has received additional support from experiments and arguments. KAAW BOERHAAVE* opened the *Thorax* and *Abdomen* of a Dog immediately after death, and by gentle pressure, emptied the Stomach of its contents through the *Æsophagus*, then injected pure warm water into it, which he saw absorbed by the small bibulous veins, and enter the larger Gastric veins, from thence pass into the *Vena Portarum*, and through the Liver into the *Vena Cava*, which, with the right Sinus and Auricle, and even the *right Ventricle*, soon became very turgid. He then tied the *Vena Cava* next the HEART, and made an opening into it below the ligature, and continued the injection till all the blood was washed out of the vessels, which remained quite pallid and white.

NOTE.

* Perspirat. dict. Hippocrati, par. 469, 470, 471.

MEKEL* asserts, that he injected the veins by throwing coloured Wax into the cavities of the *Vesiculæ Seminales*, through the *Vas Deferens*, and that he also filled the veins by injecting Air and Water into the Bladder, through the Urethra.

SWAMMERDAM put ligatures on the *Mesenteric Veins*, and after some time had elapsed, opened the veins to examine the Blood, which he found marked with a number of white lines and specks; these he supposed were the CHYLE which the veins had just absorbed from the Intestines.

FROM the above experiments it may be very rationally deduced, that the veins do arise and absorb from the cavities mentioned.

IT is well known, that whatever obstructs the due return of the blood to the HEART, through the veins, will produce Dropsy, and this dropsy was said to arise because the obstructed veins could not take up those fluids which the exhalent arteries effused.

THE veins are allowed by every one to arise by open mouths from the cells of the *Corpora Cavernosa* of the *Penis* and *Clitoris*; it is therefore probable, that they absorb from those cells. Admitting this, analogous reasoning would lead us to suppose, that they absorb all over the body.

NOTE.

* Experimenta et Obs. de finibus venarum, &c.

As it is found impossible to make any thing injected into the Vessels of the Mother, pass into those of the *Fetus in Utero*, or, *vice versa*, it is very rationally concluded, that their communication is kept up by Absorption in the *Placenta*; and as no vessels but arteries and veins are known to exist there, it is infered that, either the one or the other must do the office of Absorbents, and the veins are the most likely of the two to do it.

WE should not wonder, if this doctrine of *Venous* Absorption, so well supported by analogy, argument, and experiment, met with a very general acceptance. Accordingly we find it adopted, and supported, by a number of Writers, whose names and authority in Medicine, are second to none.

MEDICAL Philosophy in its progress to perfection, seems to keep pace with improvements in Anatomy; of this our present subject affords a striking instance.

IN the year 1622, ASELLIUS* an Italian, discovered vessels on the Mesentery of some quadrupeds that he was dissecting alive, which [vessels] contained a white fluid: he thought they terminated in the liver, and said that they absorbed chyle from the intestines, and carried it into the blood, therefore called them *Vasa Lactea*.

THOUGH he never saw the lacteals in the human subject, yet he believed from analogy, that they existed, and asserted it roundly.

NOTE.

* De Lactibus, sive de venis Lacteis Dissert.

Nicolas Claudius FABRI de PEIRESC, commonly called *PEIRESCIUS*, who died in 1637, though he never wrote any thing, yet, according to Haller, he was the first who saw the lacteals in the human subject: "*Vasa lactea in homine visa, quod primum, nisi fallor, in homine exemplum.*"*

VESLINGIUS was the first who gave engravings of the lacteals in man; and in 1647 he saw the Thoracic Duct (which *EUSTACHIUS* had seen before,) double.

IN 1651, *JOHN PECQUET* published *Experimenta nova anatomica*, in which he describes the thoracic duct as inserted into both subclavian veins, and likewise taught that the lacteals did not run to the liver as *Asellius* said, but that they met in a reservoir, situated in the loins, and ascended from thence through the thorax to the subclavian vessels.†

IN the year 1650, *RUDBECK* saw and described the lymphatics, under the name of *Vasa Serosa*, and was disposed to think that they absorbed. *BARTHOLINE* about the same time discovered them, and called them *Vasa Lymphatica*, but he thought they were continued from the arteries, and served to carry the serous and watery parts of the blood; and as he was a man of much higher reputation than *Rudbeck*, he got the credit of the discovery; and his opinion of their uses was likewise adopted. So that before the time of the two *HUNTERS* of London, and *MONRO, jun.* of *Edinburgh*, the doctrine of venous absorption prevailed universally in the Schools

NOTES.

* *Bibliotheca Anatomica*, Tom. 1, pag. 391.

† *Joannis Pecqueti. Diepæi Experimenta nova Anatomica. cap V.*

of Medicine, and the lacteals and lymphatics were treated as a trifling appendage to the venous system. Doctors *Hunter* and *Monro*, were satisfied that the lacteals absorbed from the cavity of the intestines, and were induced to think, that the lymphatics did the same from other parts, by the following considerations ;—like the lacteals, their coats are thin and transparent, and are crowded with valves, they also pass through conglobate glands ; both lacteals and lymphatics terminate in one common trunk, the thoracic duct ; they frequently anastomose with one another, and in fine they are alike in every respect, except, that one carries a white opaque fluid, and the other, a colourless transparent lymph.

IF the lymphatics were continued from the arteries as *Bartholine* thought, they ought to be injected from them, which cannot be done. The succeeding labours of these gentlemen, together with those of Messrs. J. HUNTER, HEWSON, CRUIKSHANK, and Professor MASCAGNI of *Sienna*, have proved to the satisfaction of every one, that the lymphatics and lacteals constitute a grand system of absorbents, and rendered even the possibility of venous absorption doubtful.

Mr. HUNTER* opened the abdomen of different living quadrupeds, and filled distinct portions of the intestines with milk, a solution of starch in water coloured with indigo, and a solution of musk in water ; all of which discovered themselves soon after in the lacteals of those portions of intestine into which they had been respective-

NOTE.

* Medical Commentaries by William Hunter, page 42, and seq.

ly put, by their peculiar colour or smell ; but in no instance could any thing like milk, the blue colour of indigo, or the smell of musk, be discovered in any of the veins.

WHILE portions of intestine were full of the solution of starch, coloured with indigo, milk was injected into the artery until it returned by the vein ; the milk in the vein was examined, but nothing like the blue colour of indigo was found in it.

MILK was injected into the veins until it returned by the arteries, and the injection continued some time ; on examination not a particle of milk could be found in the cavity of the intestine.

As these experiments are satisfactory in favour of absorption by the lacteals, and pretty decisive against that by the veins, we will now attempt to answer those experiments and arguments which were formerly adduced in support of *venous absorption*.

IT is well known that all the vessels, and containing viscera of the animal body, will suffer fluids to transude through their coats after death : it is therefore probable that *Kaaw Boerhaave* was deceived as to his seeing the water absorbed by the bibulous mouths of the veins, and that it got into the vessels by transudation. *Mascagni** repeated the experiment, and constantly found a portion of water in the veins and arteries, but he likewise found a

NOTE.

* *Vasorum Lymphaticorum Historia & Ichnographia*, pag. 16.

larger portion had got through the coats of the stomach into the cavity of the abdomen.

THE same author* repeated *Mekel's* experiments on the *Vesiculæ Seminales and Bladder*; and of twenty-four vesiculæ which he filled, the veins of only one were found injected; and on particular examination, it appeared that none of the smaller ramifications were filled, but, that there was a rupture in a trunk through which the matter of injection passed. In repeating the experiments on the bladder, nothing took place that might not be explained by either laceration or transudation.

IT is by no means uncommon to find the whole serum of the blood of a white cream colour, what this is owing to, we do not pretend to know; but only think it probable that *Swammerdam* met with a case of this kind in his experiments.

IF dropsy is the consequence of an obstruction in the veins, it does not follow that the veins are the absorbents; the same causes which obstruct or compress the veins will most probably do the same to the lymphatics, which run in company with them; but ligatures have been put on the veins, when care was taken that no lymphatic was included, and dropsy was the effect; here the veins not being able to receive the blood from the arteries, the latter were overloaded, and relieved themselves by an increased effusion through the exhalents; and this

NOTE.

* *Vasorum Lymphaticorum Historia & Ichnographia*, Pag. 17.

increased effusion, not any defect in absorption was the real cause of the dropsy.

THE passage of the blood through the corpora cavernosa of the penis and clitoris, is considered as a peculiar kind of circulation, not absorption. Dr. Hunter* thought the cells of these parts were of an intermediate nature between an *aneurism* and a *varix*.

No proofs, that I know of, have ever been produced to shew that the veins absorb from the cells of the placenta; and though no lymphatics are known to exist there, yet we may from analogy infer that they do exist: nay, both Mr. Cruikshank† and Mascagni‡ have seen them on the mother's part of the placenta, and other parts of the body, and even whole classes of animals, which till very lately were thought to be without them, are now known to be very plentifully supplied with them.

To return.—That the lacteals absorb the chyle from the cavity of the intestines, no one will pretend to doubt; and it is a matter of the very first importance that this absorption should go on regularly, for the chyle is the fluid into which our food is changed in the organs of digestion. Absorption then is as necessary to the continuance of the health of the animal body as digestion: nay, more so, for without absorption, immediate starvation is

NOTES.

* Medical Commentaries, by William Hunter, page 48.

† Anatomy of the Absorbing Vessels, second edition, page 28.

‡ Vasorum Lymphaticorum Historia & Ichnographia, pag. 18.

inevitable; but though digestion be entirely suspended, yet by frequently throwing milk and nutritive broths into the large intestines, by way of enema, we may support life for a month or more.

RUYSH* says, he has found the Lymphatic Glands on the Mesentery of old people almost entirely obliterated, and as these subjects appeared to enjoy good health, he concludes that the veins must have absorbed the chyle from the Intestines.

It has likewise been urged against absorption by the lacteals alone, that in cases where the Thoracic Duct has been cut through, tied, or otherways obstructed, death has not been so immediately the consequence, as it should have been, had this been the only passage by which the chyle could get into the blood.

To *Ruysh* it may be replied; that all the solids of old people shrink very much; and though their mesenteric glands be very few and small, yet, it does not follow, that the lacteals do not absorb; and *Haller†* says, he has not unfrequently found the thoracic duct full of white chyle in old subjects.

To the other objection we may answer, that the thoracic duct is often double, having one opening into the left, and another into the right *subclavian vein*.

It is agreed by every one, that absorption takes place from the surface of the body, and, that it is done by the

NOTES.

* Avers iii, n. 7. p. 23.

† *Elementa Physiologiæ*, Tom. VI, pag. 67.

lymphatics, is proved by the following observations. When the venereal *virus* is applied to any part of the body, the first place it discovers itself in, is the gland to which the lymphatics of that particular part run. The case is the same in inoculating for the small-pox, if we operate on the arm above the elbow, the first proof we have of its entering the system, is a swelling in the axillary glands.

MASCAGNI* says, he has observed that when vesicatories are applied to the superior and inferior extremities, the axillary and inguinal glands swell, and that on injecting the lymphatics of blistered parts, he found the glands obstructed.

To these may be added, the demonstration of their orifices on the surface of fishes. As the lymphatics of these animals have no valves, and therefore allow an injected fluid to pass from trunk to branch, they afforded Dr. Monro† an opportunity of examining their origin. And after injecting those of the skate, he says, “ I found that not only water, but air, milk, quicksilver, and even oil of turpentine coloured with the powder of vermillion, were discharged upon the surface of the skin, by a vast number of distinct orifices, placed at regular distances from each other ; yet the force with which these liquors were injected was very small, and there was no extravasation into the cellular substance any where under the skin, or in the interstices of the muscles.” We might ea-

NOTES.

* Vasorum Lymphaticorum Historia & Ichnographia, pag. 23.

† Structure and Physiology of Fishes, page 33.

sily infer from analogy, that absorption took place in the air cells of the lungs, as from other surfaces.

DR. MONRO * finding “ very numerous and large lymphatics dispersed upon the gills of the skate,” and knowing that “ fishes soon die when put into water from which the air has been extracted, ” seems disposed to think, they “ serve to take in from the air, which is mixed with the water, *somewhat necessary* for life:” the opinion now commonly received is, that this ‘ *somewhat necessary*,’ is oxigene, or the base of vital air. Is it not then likely, that there are absorbents particularly calculated for this purpose, in the lungs of other animals? If this be the case, it will appear, that absorption is as momentous to the continuance of animal life as respiration.

To us as Physicians, absorption from the external surface is very interesting, for two reasons, first, it points out a method of introducing remedies, and in particular emergencies, even the necessary supplies of life. Not to mention a number of other instances, every practitioner knows, that he can produce salivation and cure lues venerea, by applying mercury to the external surface of the body only.

MR. CRUIKSHANK† says, “ a patient of mine, with a stricture in the *æso-phagus*, received nothing, either solid or liquid, into the stomach for two months; he was exceedingly thirsty, and complained of making no water;

NOTES.

* Structure and Physiology of Fishes, page 35.

† Anatomy of the Absorbing Vessels, second edition, page 108.

I ordered him the warm-bath, for an hour, evening and morning, for a month; his thirst vanished, and he made water in the same manner as when he used to drink by the mouth." In cases where no nourishment can be taken into the stomach, would it not be advantageous to put the patient occasionally, into a warm nutritive bath of milk and water, or thin broth?

BUT, secondly, it is an inlet to a number of troublesome and dangerous diseases. These are, lues venerea, small-pox, and perhaps all or most other contagious maladies. Dr. *Hunter* * tells us, from the authority of Dr. *Russel*, that the plague is only to be communicated by contact, and that the buboes peculiar to it, always appear in the glands, to which the lymphatics of the part where the contagious matter was applied, are distributed. I conversed with one of the prisoners lately returned from Algiers, (an illiterate man) who seemed to think from common experience, that the plague was only taken by contact. The *virus* of rabid animals and poisonous reptiles, is likewise most probably introduced into the body by the lymphatics.

DR. HUNTER † was of opinion, that the Scrophula was owing to the absorbents being so relaxed and *bibulous* as to draw in some crude or noxious matter from the atmosphere.

THE alarming consequences of taking arsenic, lead, copper, opium, tobacco, &c. into the stomach, are well

NOTES.

* MSS Lectures.

† MSS Lectures.

known. They have produced similar effects when applied to the skin, and carried into the system by the cutaneous lymphatics.*

THE cells of the cellular membrane, and all the circumscribed cavities of the animal body, as the abdomen, thorax, joints, &c. are constantly moistened with a fine lymph, effused by the exhalent arteries, to prevent attrition, from the motion of their surfaces on one another; if this lymph was not absorbed, it would accumulate in such quantity as to produce dropsy, and prove the destruction of the animal. That this absorption is performed by the lymphatics, we have the following proofs:

MASCAGNI† says, “Cum sanguis insuggillatione panniculum adiposum, ac celluloseum textum occuparet, eodem sanguine vasa lymphatica, quæ ex his partibus oriebantur, repleta pariter inveni: cum inter musculos stagnaret, vasa ex is prodeuntia sanguine similiter repleti observavi.”

AND again, ‡ “Quoties in partibus inflammatione affectis globulos sanguineos in celluloso textu extra vas deprehendi, toties me ipso observante intra lymphatica ex his partibus derivantia lymphæ rubra, & densior continebatur, & glandulæ, quo ea ferebantur vasa, præ aliarum partium glandulis intensius rubebant. Siquando autem in partibus inflammatis extra vas globulos sanguineos non

NOTES.

* Haller *Elementa Physiologiæ*. Tom. V. pag. 86, 87.

† *Vasorum Lymphaticorum Historia & Ichnographia*, pag. 21.

‡ *Vasorum Lymphaticorum Historia & Ichnographia*, pag. 21.

inveni, tunc serum non deerat densius levi colore luteo tinctum, a quo et vasa lymphatica replebantur." These appear to me, satisfactory arguments, that the lymphatics absorb from the cellular membrane.

THE same author * relates a case, where the cavity of the abdomen was filled with a milky fluid, from a laceration in the duodenum ; the same matter had made its way into the more minute branches, trunks and glands of the lymphatics, even into the thoracic duct.

MR. CRUIKSHANK† has found the lymphatics of the lungs full of blood in subjects which died of Hæmoptoe ; and when blood was effused into the cavity of the thorax, Mascagni‡ has found the lymphatics on the surface of the lungs, diaphragm, and *pleura costalis*, full of the same.

THESE observations leave but little doubt, that the lymphatics absorb from these cavities, and it is no great stretch of analogous reasoning to suppose they do the same from other circumscribed cavities. There was formerly some difficulty in admitting this analogy with respect to the ventricles of the brain, because it was not certainly known that lymphatics were to be found there ; but Dr. Haller § who was by no means an advocate for the universality of the lymphatic system, says of Nuek, "lymphatica vasa pene ubique, in abdomine, teste, pede re-

NOTES.

* Vasorum Lymphaticorum Historia & Ichnographia, pag. 20.

† Anatomy of the Absorbing Vessels, second edition, page 42.

‡ Vasorum Lymphaticorum Historia & Ichnographia, pag. 21.

§ Bibliotheca Anotomica, Tom. I. pag. 686.

perit ; in cerebro, sed rarius ;” and Dr. *Monro** has found the brain of fishes plentifully supplied with them ; *Mascagni*† has likewise given an engraving of some in the human subject.

THERE is a disease to which the human body is liable, and in which the absorbents are always either positively or relatively concerned, I mean dropsy.

THIS may depend on three distinct general causes.—
1st. The Absorbents may continue to take up as much as usual ; but the quantity of fluids effused by the exhalents may be so increased, as to produce dropsy ; of this kind I take all those dropsies to be, which attend an obstruction to the circulation of the blood, likewise those which are the consequence of inflammation, and also, all those that are attended with symptoms of the plethoric state of the sanguiferous system.

2d. DROPSY may arise from the lymphatics being obstructed or impervious ; *Mascagni*‡ says he frequently met with dropsical bodies in which the conglobate glands were so obstructed, that mercury injected into the lymphatics could not be made to pass through them. The œdema which takes place in the lower extremities of women, in the latter months of pregnancy, is most likely owing to the pressure of the uterus obstructing the lymphatics about the brim of the pelvis. These two causes of dropsy may be, and I believe often are united in the same case.

NOTES.

* Structure and Physiology of Fishes, page 32 .

† Vasorum Lymphaticorum Historia &c. Tab. xxvii, Fig. i, ii, iii.

‡ Vasorum Lymphaticorum Historia & Ichnographia, page 20.

3d. DROPSY may arise from an universal debility or relaxation of the whole system, or from debility and relaxation of the lymphatics in particular. "Alias in hydropicis," says *Mascagni*; *mercurio replendo lymphatica, hoc dumtaxat animadverti ea in truncis, & glandulis ob auctam diametri amplitudinem, latius protendi, valvulasque in truncis majoribus regressum mercurio non impedire.—To this debility and relaxation, may be referred all those dropsies which are the consequence of copious evacuations, or which attend great weakness produced by any other cause.

IT appears probable, that all these causes of dropsy may be united and complicated to a very great variety.

MASCAGNI † says "In ictericorum cadaveribus cum bilis ductu coledicho obstructo intra poros biliarios detineatur, lymphatica hepatis tam superficialia quam profunda bilem amaram, et coloratam continebant."

THIS appears to be sufficient proof, that the lymphatics absorb from the gall-bladder and *pori biliarii*; and it may be infered from hence, that they do so from all other secretory and excretory organs.

IT is not clearly ascertained, whether the lymphatics do arise and absorb from the cavities of the vessels of the sanguiferous system, or not.

NOTES.

* Vasorum Lymphaticorum Historia & Ichnographia, pag. 21.

† Vasorum Lymphaticorum Historia & Ichnographia, pag. 21.

THE alveolar processes of the jaw-bones of old people, are entirely removed after the teeth have fallen out.

THE venereal disease produces *nodes* or bony excrescences on the tibia and other bones, which may afterwards be removed by the use of mercury. When tumours in other parts have pressed for a great length of time on a bone, the bone is often almost entirely removed. And hard schirrous tumours have remained a long time in the glandular parts of the body, which have again returned to their natural state.

ALL these facts shew that the solids as well as the fluids are occasionally taken up. And Mr. *John Hunter* ingeniously suggested that they were absorbed by the lymphatics.

WHETHER the solids loose the attraction of cohesion, and are reduced to a fine powder, or are converted to a fluid by a peculiar fermentative process, or how they are rendered fit to be acted upon by the absorbents, we are entirely at a loss to determine.

IN the process of sloughing and exfoliation, or the separation of living from dead solids, the line of division appears to be formed by an absorption of the living parts.

THE disease called *mollities ossium* is, very probably, owing to the absorption of the earthy parts of the bones.

WE sometimes meet with bones which have not more than half the usual specific gravity, this likewise may be owing to a morbid absorption.

As to the manner in which the absorbents take up fluids ; the most probable opinion appears to be, that they attract them as capillary tubes.

THIS opinion is not without its difficulties : the Lymphatics as capillary tubes ought to absorb at all times, when any fluid is presented to them, which does not appear to be the fact. Dr. Monro* from his observations on the *echinus marinus* or sea-egg, has accounted for this satisfactorily, and says, “ We are led to the conclusion, that the absorbent tube is by its proper muscular action, and perhaps also by an influx of liquors into the arteries which are dispersed on its coats, made tense, and its cavity at the same time much contracted ; in consequence of which it acquires the property of a glass capillary tube, of attracting liquors, which, by the well regulated action of its muscular fibres, are pushed onward from their entrance to their termination.”

As the lymphatics and lacteals of men, and most other animals are crowded with valves, it might be thought that the motion of absorbed fluids in them, was kept up by the pressure of neighbouring parts ; but as the coats of these vessels are very contractile and irritable, and the lymphatics of fishes are without valves, we conclude with Dr. Monro, that it is by the action of the vessels themselves ; admitting, however, that the pressure of neighbouring parts does assist, whenever valves are found.

NOTE.

* Structure and Physiology of Fishes, page 71.

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